Reallocation of Labor Resources: Evidence from Danish Firm Data *

Ija Trapeznikova †

Abstract

This paper presents empirical evidence based on a unique dataset drawn from a matched employer-employee panel of Danish firm data that illustrates the importance of reallocation of labor resources from less to more productive firms for aggregate productivity growth. This reallocation is more prominent when differences in the work hours across firms are accounted for. In addition, this study explores the dynamic interaction between hours and employment found at the firm level. Empirical facts presented here suggest that in the short run firms use the variation in hours to mitigate changes in the number of workers.

1 Introduction

Large and persistent firm productivity and wage differentials have been reported by existing empirical studies for various countries and time periods ([9] provide an excellent review of the literature). Another widely cited finding in the literature is that productivity and wage differentials across firms are closely related (see for instance [20]). The fact that more productive firms pay on average higher wages implies that workers have an incentive to seek for higher paying jobs and move to more productive firms. The existence of intrinsic productivity differentials means that reallocation of labor from less to more productive firms will generate efficiency gains. Recent literature has shown that such reallocation may well account for a large fraction of both the level and the growth rate of aggregate productivity (see among others [21] for the US data and [29] for the Danish data).

*This paper has been written as a part of my PhD thesis. I am grateful to my PhD advisor, Dale Mortensen, for his extensive help and guidance throughout this project. I wish to express my special thanks to Henning Bunzel for sharing his expertise on the data. I also thank the Statistical Office of Denmark for granting me access to the data.

†Department of Economics, Royal Holloway, University of London. Contact: ija.trapeznikova@rhul.ac.uk.

The idea of growth-enhancing reallocation relies on the assumption that labor market frictions - such as the costs of searching for new employees, hiring and training costs, dismissal notice periods, mandated severance pay, etc. - prevent firms from adjusting their employment in response to productivity changes. In order to understand the extent to which labor adjustment costs hinder the reallocation of labor resources across firms, I examine and document the ways in which firms vary their labor resources. Firstly, I analyze labor dynamics distinguishing between gross and net employment changes. Secondly, I investigate the trade-off between changes in the number of workers that the firm employ and the number of hours that each employee is working.

The empirical analysis in this paper is based on a unique dataset drawn from a matched employer-employee panel of Danish administrative firm data that contains all private firms in the economy for the period of 1999-2006. This dataset provides quarterly information on total work hours, payroll costs, and value added, while employment information is available on a monthly basis. These micro data have a number of advantages. Firstly, a labor productivity measure used in this paper accounts for differences in labor utilization across firms: firm productivity is constructed as a ratio of value added to total labor input, where labor input is measured as the total firm-level work hours (as opposed to using the number of workers or the product of the number of workers and industry-level average hours as in [21]). Secondly, most of the existing studies, which explore the connection between firm-level and aggregate productivity growth and the role for reallocation, focus predominantly on the manufacturing sector (see for example [8]).[1] The data in this paper allow for a broader analysis that includes all private businesses in the economy. Thirdly, high-quality longitudinal links ensure that firm entry and exit can be identified precisely, which enables me to investigate the effect of entry and exit on labor productivity dynamics.

In this paper, I distinguish between job and worker flows in light of their distinct implications for labor adjustment costs. To achieve the same net employment change firms may modify their attrition rates, as opposed to hiring or laying off employees, and in that way avoid paying hiring and training costs. In the data, time-consistent firm and person identifiers ensure that accurate monthly hiring and separation flows can be constructed. The two questions I address here are: do contracting firms shut down their hiring channels and rely on attrition or do they increase their separations, and vice versa, do growing firms raise their hiring rates or do they devote more resources to retention rates?

[1] [21] is a notable exception: they analyze the retail trade sector in the US.

The scarcity of high-frequency micro data on work hours is the dominant reason for the lack of a detailed analysis of the trade-off between changes in hours and employment. Due to data limitations, most of the existing empirical literature on labor input dynamics that exploits information on work hours refers to industry-level data (see for instance [31] and [26]). [16] use establishment-level data that pertain to the US manufacturing sector and that are more than three decades old.[2] The dataset used in this study allows me to examine firm-level dynamics of hours and employment on a quarterly basis. Moreover, the Danish firm data include all private businesses in the economy, hence enabling the comparison of labor adjustment patterns across industries.

I begin my analysis by documenting differences in labor productivity and wages found among firms in the Danish labor market. I find that more productive firms pay higher wages, in line with rent-sharing theories. Gross expansion and contraction rates of input and output are about 20% a year, with most of reallocation happening within the same four-digit industries. I show that more productive firms increase their use of labor resources, whereas less productive firms lose their workforce. Furthermore, this reallocation pattern from less to more productive firms is more prominent in terms of total hours than in terms of employment, suggesting that firms adjust both the number of workers they employ and their average work hours. Over the period of 2002-2006, about half of the expansion in output and labor input is accounted for by entering and exiting firms.

I show that the Danish labor market is characterized by considerable magnitudes of job and worker flows: monthly hiring and separation rates average about 9 percent; whereas job creation and destruction rates exceed 5 percent. I find that worker flows and job flows are quite distinct, with only about one third of monthly hires and separations associated with job creation and job destruction, respectively. At the same time, expanding firms rely primarily on hires, while contracting firms reduce their workforce mostly through separations.

Finally, the analysis of labor input dynamics at a quarterly frequency reveals a negative association between growth of hours and employment suggesting that in the short run the variation in hours can partly replace changes in the number of workers. Moreover, changes in work hours precede changes in the workforce. These observations are consistent with the idea of a fast response in hours to productivity changes and a more sluggish response in employment.

[2]They build their analysis on the Longitudinal Research Database, which includes quarterly work hours information at the establishment level for a sample of manufacturing firms for the period of 1972-1980.

Overall, substantial productivity and wages differentials found among firms in the same narrowly defined industry and a high pace of reallocation of labor resources suggest that reallocation dynamics plays an essential role in aggregate productivity growth. I show that labor utilization, measured by the average work hours, is an important channel through which firms adjust their labor resources. In the short run, changes in hours serve as a substitute to employment variation.

The paper proceeds as follows. Section 2 provides a brief description of the Danish labor market, focusing primarily on the role of collective bargaining. In Section 3, I give details on the data sources used for the analysis and on the construction of variables of interest. Section 4 presents empirical facts about the shape and evolution of the labor productivity distribution among Danish firms and examines the link between wage and productivity differentials. I report the gross reallocation rates of input and output and the effect of firm entry and exit on productivity dynamics. Section 5 explores the variation in firm-level employment in detail, based on monthly job and worker flows. In Section 6, I investigate a dynamic interaction between changes in employment and changes in work hours per employee. The last section summarizes key findings.

2 Danish labor market

The Danish labor market is regulated mostly by collective bargaining agreements between trade unions and employer organizations: about 80% of all employees are unionized.[3]. Collective agreements regulate wages and main issues pertaining to work conditions, such as overtime, paid leave, etc. One feature of this system is that there is no statutory minimum wage; instead, collective agreements are the main mechanism for regulating low pay. In general, there are three ways in which wages are determined. First, the standard pay system means that wages are set in a centralized way under the framework of the collective bargaining agreement and no local adjustments of pay are allowed. The second system is fairly flexible in that it allows for firm-level wage negotiation, while the central bargaining determines only a minimum wage. Finally, the third system is completely flexible and has no centrally agreed pay rate. The recent tendency in the labor market is for the unions to play the role of a coordinating institution, whereas wages are negotiated at the firm level. The percentage of union members that were covered by the fixed pay rate system has decreased over the past decades from

[3]See Danish Confederation of Trade Unions website (as downloaded on May 20, 2010): http://lo.dk/Englishversion/About%20LO/TheDanishLabourMarket.aspx

34% in 1989 to 16% in 2004, while the opposite is true for the flexible wage setting - its share among all employees has risen from 4% in 1991 to 22% in 2004.[4]

There is no statutory protection against dismissals as there is no statutory minimum wage. Collective agreements' rules on individual dismissals are particularly flexible, which makes the Danish labor market one of the least rigid by international standards.[5] Long-term employees receive an average of one month's wage compensation upon dismissal. For comparison, a severance pay in Portugal is three months of wages for short-term employees and up to twenty months for long-term employees; up to four months of wages in France, up to nine months of wages in Netherlands and up to a year in Spain.[6] Regulations on dismissals may differ across industries. For instance, average notice periods vary from three days in construction to one month for industrial workers and up to three months for salaried workers depending on their seniority in a firm.[7] The reason for short notices is that employees in turn have flexibility to switch jobs: workers are required to notify their employers eight days in advance if they want to quit. In addition, there has been an increase in the use of temporary contracts and there are no longer limitations on how often these temporary contracts can be renewed.

Working time has always been one of the primary issues in collective bargaining in Denmark; however, until the 1980s the total length of the workweek has been the dominant concern. In the mid-1990s the focus shifted to the variability of working time allowing for additional flexibility of work hours. For instance, in the manufacturing sector the collective agreement was introduced in 1998 that specified that working time could vary over a twelve-month period as long as the average weekly hours amounted to 37 hours a week, provided that an agreement between management and a union representative

[4]Source: [4].

[5]Here, I refer to measures of labor market flexibility developed by [12]. Their original data have been extended by the World Bank and are available at http://www.doingbusiness.org/ExploreTopics/EmployingWorkers/. Difficulty of firing index, which includes requirements for grounds for dismissal, dismissal procedures, severance pay and terms of notice, is 0 out of 100 in Denmark compared to, for instance, 30 in France, 40 in Italy, and an average of 22.6 for OECD countries. Overall rigidity of employment index, which refers to legal requirements concerning minimum pay, working time, paid holidays, use of part-time and fixed-time contracts, and dismissal procedures, is reported to be 7 out of 100 for Denmark compared to 26.4 OECD average (as downloaded on May 10, 2010).

[6]"The flexible labour market needs strong social partners. The European discussion on the Danish Labour Market: Flexicurity". Published by the Danish Confederation of Trade Unions on January 2008: http://lo.dk/Englishversion/~/media/LO/English/FinalFexicurity.ashx (as downloaded on May 10, 2010).

[7]In the manufacturing sector's agreement, for employees under six months of service the employer is under no obligation to give a notice, then the term of a notice rises with service proportionally so that an employee with 12 years of service has a right to a 120 days' notice ([4]).

is reached locally. Further changes were made in 2004, which stated that specific organization of the working time could be agreed upon directly with an individual employee or a group of employees.[8]

Denmark is characterized by a relatively generous unemployment insurance (UI) system. The system is based on the UI funds with voluntary individual membership. About 70% of employees are members of an UI fund (see [5] and the references therein). Contribution rates are the same across all funds; moreover, the UI funds are subsidized by the public sector. The entitlement to benefits begins on the day of registration (no backdating is possible) and continues for up to four years. Beyond four years of receiving UI benefits or in the case of not being a member of any UI fund, the individual is eligible for social assistance. The replacement rate - the ratio of UI benefits to wages - depends on the previous income and is about 60% on average.

One of the main pillars of the Danish unemployment insurance system is participation in active labor market policies (ALMPs), mainly related to job training and education. OECD Employment Outlook provides an estimate of the total expenditures on active labor market policies in Denmark of about 1.3% of its GDP, the highest percentage among all OECD countries in 2004. After nine months of unemployment (six month for individuals younger than 30 or older than 60), workers are obliged to enter the active labor market programs to stay eligible for UI benefits. About 20% of all unemployed and 40% of those receiving social assistance participate in ALMPs (see [5]). [5] show that although the registered unemployment rate in Denmark is fairly low averaging 6% during the period of 1999 to 2006, the gross unemployment rate (that includes the registered unemployed and people participating in job training programs, paid leave schemes and early retirement) is twice as high reaching 14% during the same period.

To sum up, the Danish labor market is one of the most flexible in Europe permitting firms to adjust their workforce under a minimum set of regulations. Lax dismissal rules in combination with a generous unemployment insurance scheme result in a very mobile labor market. Moreover, recent trends towards decentralization of bargaining allow for more flexibility in determining both wages and working time because many conditions can now be negotiated at the firm level.

[8]Source: [4].

3 Data

This section describes four main data sources used in the analysis, as well as the construction of the variables of interest. The empirical analysis in this paper is based on a matched employer-employee panel of Danish firms.[9] It includes all private businesses in the economy over the period of 1999-2006. This dataset is unique in a number of ways. First advantage of this dataset is that firms' entry and exit can be identified precisely, which enables me to investigate the effect of entry and exit on labor productivity dynamics. Secondly, it provides information on work hours of firms' employees making it possible to construct a more accurate labor productivity variable, compared to a labor productivity measure based on the average industry-level hours used in the previous literature (see for example [21]). Moreover, the information on employment and hours is available at a fairly high frequency (monthly or quarterly), which is ideal for the investigation of a dynamic relationship between adjusting two labor inputs - the number of workers and the average work hours of each employee. Finally, the data are drawn from administrative records and therefore are more precise than survey-based datasets used in existing empirical studies (see for instance [16]).

3.1 Employment

The first dataset is a matched employer-employee panel that includes all individuals that have paid employment in a given month. The number of workers for each firm is obtained as a head count of all individuals employed in that firm. Quarterly employment is derived as an average of three months employment. The particular structure of this dataset enables me to construct monthly hires and separations for each firm. Moreover, high-quality longitudinal links ensure that thus constructed worker and job flows series are accurate. Overall, the dataset has more than 10 million firm-month observations.

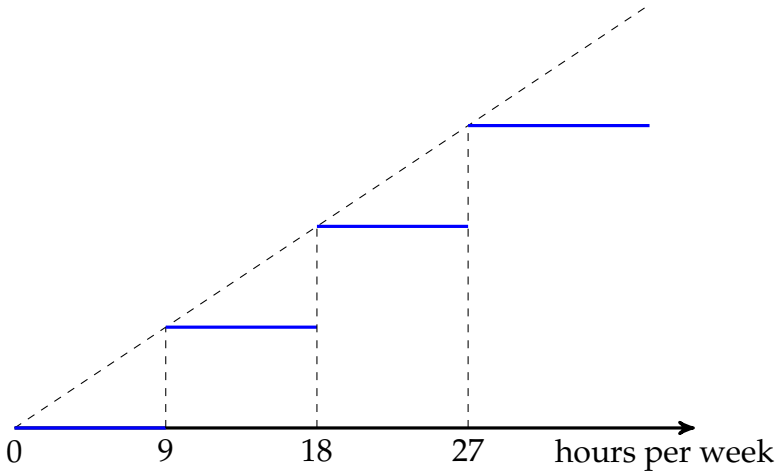
[9] According to the FIDA dataset (yearly matched employer-employee data that provides information on establishment level employment), more than 99.9% of firms are one-establishment units; while less than 0.1% of firms have more than one establishment (multi-establishment units comprise about 5% of total employment). Therefore, the results in this paper are comparable to previous studies that have used establishment-level micro data.

3.2 Hours

A work hours series is derived from the second data source, which contains firm mandatory pension contributions data collected on a quarterly basis. In Denmark, firms are required to pay pension contributions for each employee according to her weekly hours of work in the following way (also depicted in Figure 3.2):

- a full contribution is paid for any employee working more than 27 hours a week;
- two thirds are paid for any employee working between 18 and 27 hours a week;
- one third is paid for any employee working between 9 and 18 hours a week;
- zero contribution is paid for any employee working less than 9 hours a week.[10]

Figure 1: Mandatory pension contribution scheme



Each firm reports the sum of its quarterly contributions over the full set of its employees. Given the proportionality of this schedule, I construct a work hours measure

[10]It is important to note that the mandatory pension contributions are differentiated in accordance with the collective wage agreements: for some employees in the public sector full contributions (A-type) are paid, while for other employees B, C, or D contributions are paid. These rates of contributions make up, respectively, about 40%, 60%, and 48% of the ordinary contributions (further details on pension contribution rule can be found on Statistics Denmark website www.dst.dk and ATP Pension Fund website www.atp.dk). The exact distribution of employees by type of the pension plan is known only on a yearly basis; therefore, if some workers switch to a different plan within a year then the reported FTE measure will be incorrect. Given that B, C, or D contributions are paid primarily in the public sector,the empirical analysis is restricted to private firms. After the exclusion of the public sector, there are about 0.6% of firm-quarter observations that report having paid other than A-type contributions. These observations are removed from the analysis to avoid the hours measurement inaccuracy.

by dividing the total sum of payments by the payment amount for a full-time employee and multiplying by 27 hours a week times an average of 13 weeks a quarter

$$H_{LB} = (27hrs * 13wks) * N^*, \tag{LB}$$

where N^* is the full-time equivalent employment derived as

$$N^* = \frac{\text{total pension contributions}}{\text{a contribution amount for a full-time employee}}.$$

Implicitly, I assign the left boundary of the respective 9-hour interval to all workers so that the hours variable constructed in this manner represents a lower bound on the total quarterly work hours.

Alternatively, I construct an upper bound measure of work hours, for which I use the right boundary point for each of the 9-hour intervals depicted in Figure 3.2. The right boundary of the last interval is assumed to be 36 hours a week. This assumption, albeit not very realistic, preserves the proportionality of the hours schedule. Also, if the number of workers in a given firm is higher than the number of full-time employees, I allocate 9 hours of work to those extra workers. In sum, the upper bound on weekly work hours per employee is defined as

$$H_{UB} = (36hrs * N^* + 9hrs * (N - N^*)\mathbf{1}\left[N > N^*\right]) * 13wks, \tag{UB}$$

where N^* is full-time equivalent employment and N is the number of workers. Both hours measures give very similar results for most of the empirical relations presented in this paper with the exception of hourly wages and hours relationship that is discussed in detail in Section 6. Thus, the moments below are based on the lower bound measure of work hours unless stated otherwise.

Combining work hours data derived from firms' pension contributions with quarterly employment, I compute a quarterly hours per worker series for each firm, which I use as a measure of labor utilization. It is important to bear in mind that this hours variable, due to its interval nature, may mask some of the variation in actual hours that happens in response to changes in demand, input prices, etc. This is particularly true in the event of a positive shock since it is impossible to identify overtime. Changes in labor utilization will be reflected in the data only when employees move between the 9-hour intervals, for instance, if at least some workers switch from part-time to full-time jobs. Therefore, the observed hours variation is likely to be underestimated in this case.

One can argue that firms have a monetary incentive to adjust hours only within (and not between) the 9-hours intervals in order to minimize pension contributions they have to pay. The level of pension contributions, however, is relatively low compared to other labor costs, such as wages, income and social security taxes – a pension contribution for a full-time employee amounts to about 1% of average wages. It is unlikely that firms have economically significant incentives to "bunch" workers at the right boundary point of each interval. To verify this hypothesis, I use the Earnings Survey that collects information on paid hours of each employee for a given year or for a length of a job spell if it was shorter than a year. It contains all private firms with more than 10 full-time employees, with the exception of agriculture and fishery.

Figure 3.2 shows the distribution of the average work hours for salaried (top panel) and pay-rate workers (bottom panel). Average work hours of salaried workers (that comprise about 55% of workers in the data) show little variation: more than 60% of them work about (or exactly) 37 hours a week. On the other hand, average hours of workers that are paid on a pay rate basis are distributed across all levels of hours. This graph shows no evidence of "bunching", expressed as a higher mass of workers at the right boundary points of the pension scheme intervals.

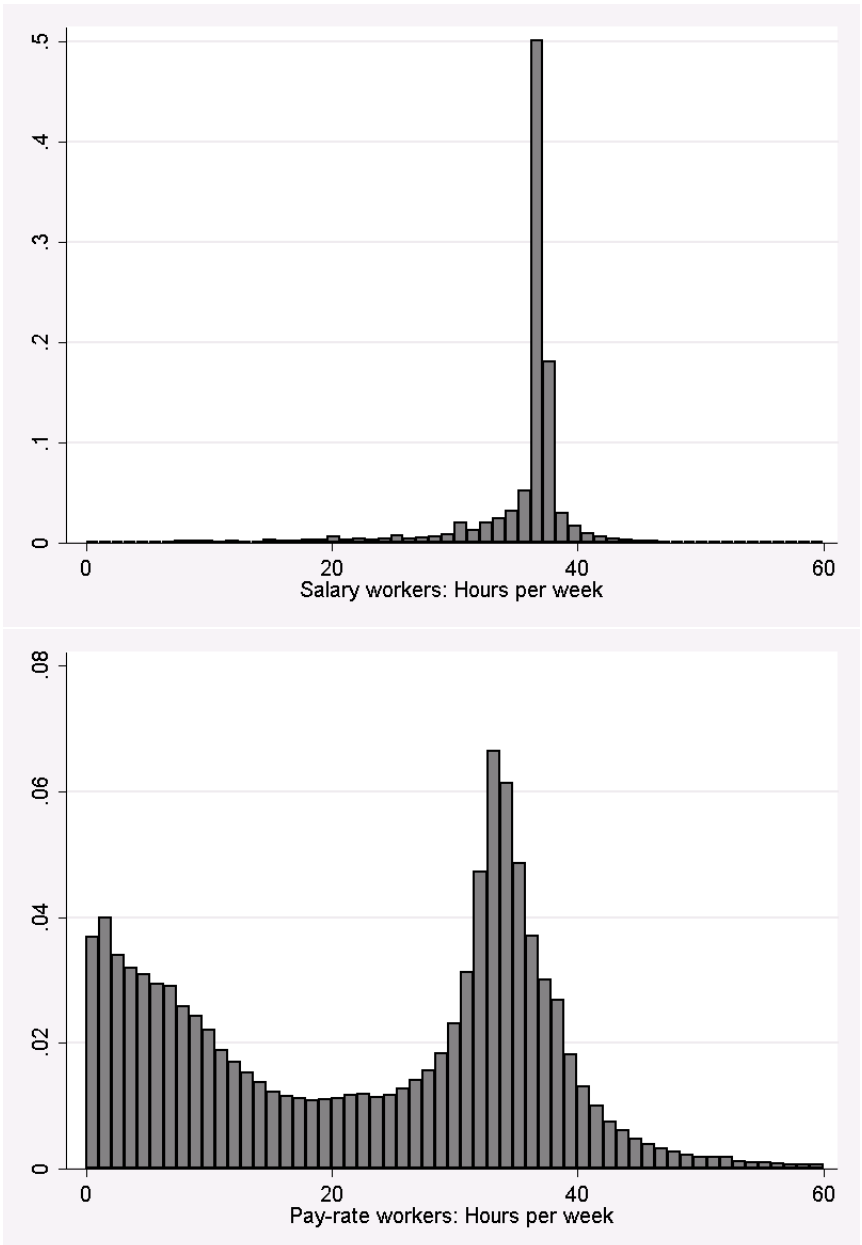
3.3 Wages

The third dataset contains information on total payroll costs that firms pay in a given quarter. Wages are measured in Danish Kroner (DKK) and are deflated using quarterly CPI with 2001 Q1=100. Hourly wages are computed for each firm as

$$\overline{w} = \frac{W}{H_{LB}},$$

where W is a total payroll cost paid in a given quarter and H_{LB} is the lower bound on the total work hours defined in equation (LB). Wages defined in this manner represent an upper bound on the firm's hourly wages. An alternative measure of hourly wages, $\underline{w}$, is constructed using the upper bound of work hours, H_{UB}, as defined in equation (UB). The latter measure admits firms with zero pension contributions and positive employment, which would otherwise be dropped from the analysis. The (upper bound) hourly wages less than 80 DKK per hour are excluded from the analysis. This figure is regarded as an estimate of the effective minimum wage. In addition, I exclude the wage rates of the top one percent of the observed distribution. The resulting dataset has about 3 million firm-quarter observations.

Figure 2: Average hours per week for salaried and pay-rate workers



Notes: The vertical axis show the fraction of workers in each hours category. Source: Author's calculations based on the Danish firm data, 2006.

3.4 Value added

The fourth dataset is drawn from value added tax (VAT) statistics over the period of 2002-2006. It provides information on purchases and sales of all VAT-liable businesses on a quarterly basis, measured in Danish Kroner (DKK). In Denmark, a business enterprise must register for VAT if its annual turnover is expected to exceed 50,000 DKK. The VAT declaration frequency depends on the annual turnover: firms report monthly if their annual turnover exceeds 15 million DKK, quarterly if their turnover is between 1 million DKK and 15 million DKK, and semi-annually if it is below 1 million DKK. To minimize sample selection, I use yearly information on value added to include all firms regardless of their reporting frequency. About 20% of firm-year observations have missing or imputed purchases and sales information and thus are excluded from the analysis. I use the GDP deflator to deflate purchases and sales data.

Value added variable, R, is computed as sales less purchases. Similarly to the hourly wage measure described above, I construct a labor productivity series as the ratio of value added to total labor input:

$$\overline{y} = \frac{R}{H_{LB}},$$

The labor productivity variable defined in this manner represents an upper bound on actual productivity. On average, the data contain about 100,000 firms per year.

4 Productivity and wage dispersion

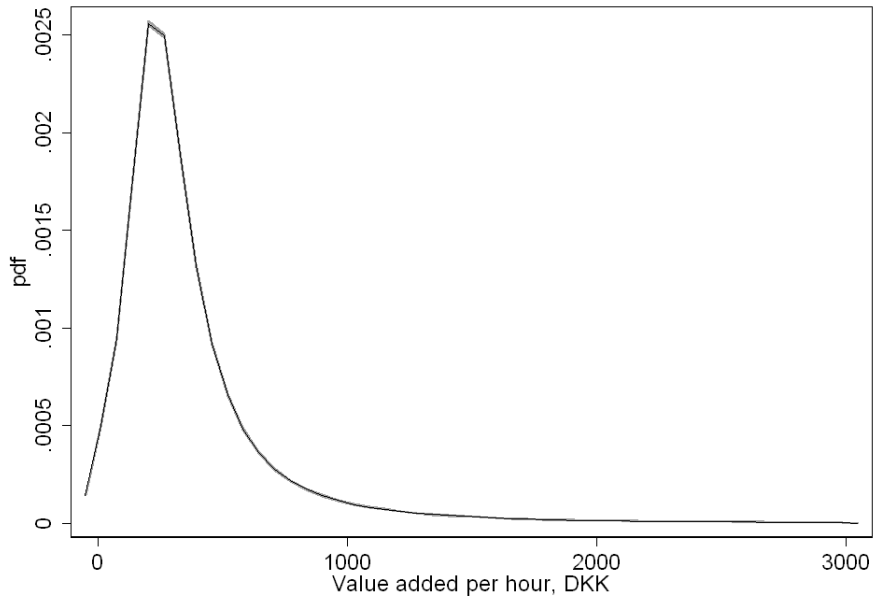
This section presents empirical facts about the shape and evolution of the labor productivity distribution found among Danish firms. I document significant and persistent labor productivity and wage differentials, which provide an important role for reallocation of labor inputs as one of the driving factors of aggregate productivity growth. I examine the effect of firm entry and exit on productivity distribution, as well as the differences between industries. This section also draws the connection between the distribution of wages and productivity across firms.

4.1 Productivity dispersion

It is a well-documented fact in the literature that productivity distribution is significantly dispersed and skewed to the right (see Figure 4.1). In Denmark, the ratio of average value added per employee for firms in the ninth decile of the productivity dis-

tribution relative to the average in the first decile is about 7 to 1. After accounting for differences in work hours among firms, labor productivity has a slightly lower dispersion: the 90th to 10th ratio falls down to 6. The interquartile range of (log) labor productivity averages 0.82, which is higher than 0.57 found by [21] for the US retail trade service and comparable to 0.85 found by [22] for the US manufacturing sector. Overall, these observations are in line with empirical facts documented for other datasets (see [9] for a review). Moreover, similar results are obtained when using alternative measures of output such as sales or domestic sales (sales excluding exports).

Figure 3: Productivity distribution



Notes: Nadaraya-Watson estimate using a Gaussian kernel with bandwidth of 30. Shaded area is 90% pointwise bootstrap confidence intervals (clustered by firm ID). Source: Author's calculations based on the Danish firm data, 2002-2006.

Table 1 presents a transition matrix that traces the evolution of individual businesses in the productivity distribution over the period of 2002-2006. In particular, I focus on five quintiles of hours-weighted productivity distribution in year t and examine, conditional on survival, what fraction of firms in each of these quintiles end up in the corresponding five quintiles in year $t+1$. Table 1 also reports the fraction of firms in each quintile in year t that did not survive until year $t+1$, as well as the distribution of entrants over the quintiles in year $t+1$.

The first thing to notice is that the diagonal elements of the transition matrix are al-

Table 1: Transition matrix of relative productivity.

	Quintiles (Year $t+1$)					Fraction of firms
Quintiles (Year t)	1	2	3	4	5	that exited
1	0.628	0.209	0.083	0.052	0.028	0.137
2	0.193	0.468	0.245	0.075	0.020	0.117
3	0.059	0.218	0.461	0.215	0.047	0.113
4	0.041	0.074	0.184	0.507	0.194	0.112
5	0.016	0.019	0.039	0.168	0.758	0.112
Fraction of entrants by quintiles	0.254	0.201	0.193	0.170	0.183	

Notes: Weighted by hours. Quintile 1 is the lowest productivity and quintile 5 is the highest. For each pair of quintile combination ij, each cell shows what percentage of firms in quintile i in year t moved to quintile j in year $t+1$, conditional on survival. The last row shows the average distribution of entrants over the five quintiles in year $t+1$. The last column shows the average fraction of firms in each quintile in year t that exited in year $t+1$. Source: Author's tabulations from the Danish VAT statistics data, 2002-2006.

ways higher than the off-diagonal, which means that there exists significant persistence in terms of productivity rankings. This pattern is more prominent for the top and bottom quintiles. Conditional on survival, firms in the top quintile had on average a 76% chance of staying in the top quintile also next year and only a 1.6% chance of moving to the bottom quintile. Likewise, businesses in the lowest quintile had a 63% chance of keeping their relative position after a year and only a 2.8% chance of moving to the top quintile. Firms in the middle range of productivity distribution exhibit considerable movement also between quintiles over a one-year period.

It is evident from Table 1 that entering and exiting firms are distributed fairly uniformly over the quintiles. The probability of exiting next year is slightly higher among low productivity firms: about 13.7% of firms in the bottom quintile did not survive until the next year, whereas for the top quintile the exit rate is 11.2%. Entrants are more likely to arrive into the bottom two quintiles than in the top two.

Table 2 contrasts firms across five quintiles of the productivity distribution in terms of their output and their use of labor resources. For each year t, the yearly growth rates are expressed as first differences of log variables between year $t+1$ and t. By construction, average productivity is increasing from the bottom to the top quintile. The same relationship holds true for the level of output. However, the growth rates of labor productivity and output show a reverse pattern. More productive firms increase their use of labor resources by both hiring more employees and raising work hours per

employee. Given diminishing returns to labor, more intensive use of labor inputs leads to a lower (and eventually negative) future growth rates of productivity. For instance, firms in the top quintile increase their workforce by 4% and their total labor input by 8%; whereas their labor productivity falls by 27%. Firms in the bottom quintile, on the contrary, lose 2.4% of their workers and reduce their total labor resources by 14%, at the same time experiencing a 37% increase in their labor productivity and a 23% increase in output.

Table 2: Reallocation of resources across firms by quintiles of the productivity distribution.

	Productivity distribution quintiles				
	1	2	3	4	5
Log labor productivity	4.44	5.35	5.64	5.98	6.79
Growth rate, %	37.2	6.0	-1.4	-8.5	-27.3
Employment	18.1	19.1	19.0	16.8	12.4
Growth rate, %	-2.4	-1.0	0.1	1.4	3.7
Total hours	20,074	22,170	22,044	19,052	13,072
Growth rate, %	-14.1	-9.5	-7.7	-4.0	7.7
Output, in 1000 DKK	2,034	4,700	6,198	7,542	19,893
Growth rate, %	23.1	-3.7	-9.3	-13.1	-21.0

Notes: Quintile 1 is the lowest productivity and quintile 5 is the highest. For each year, all variables are computed for firms in a given quintile in that year, then averaged over the period of 2002-2005. Yearly growth rates are expressed as first differences of log variables. Source: Author's tabulations from the Danish VAT statistics data, 2002-2006.

The evidence presented in Tables 1 and 2 shows that there is considerable turnover of firms in terms of the relative productivity ranking and the reallocation of labor resources associated with these productivity changes. To examine these issues more directly, I estimate average yearly gross expansion and contraction rates of labor input and output over the period of 2002-2006. Expansion (contraction) rates are defined as an average of the growth rates of expanding (contracting) firms, where the growth rates between year t and year $t+1$ are normalized by the average output or input over the two periods. This procedure generates growth rates in the interval $[-2, 2]$ with endpoints corresponding to entry and exit (for more details on the properties of this rate measure see [18]). Table 3 shows that growing firms yield on average a yearly gross rate of expansion of 22% for output and about 12-19% for labor input. Contracting firms exhibit a yearly gross rate of contraction of 19% for output and 8-15% for input. The five-year gross rates of

about 60% of expansion and 50% of contraction are similar to the rates reported for the US retail industry by [21] and are larger than the rates documented by [22] for the US manufacturing sector. Over the period of 2002-2006, entering firms account for about 35% of output expansion and about a half of employment expansion; analogously, over 50% of contraction of both output and input can be attributed to exiting firms.

Table 3: Expansion and contraction rates of output and input.

	Output		Employment		Hours	
	1-year	5-year	1-year	5-year	1-year	5-year
Expansion rate	0.215	0.641	0.117	0.578	0.186	0.620
Contraction rate	0.185	0.496	0.084	0.464	0.150	0.493
Net change	0.030	0.145	0.033	0.114	0.036	0.127
Excess reallocation	0.360	0.992	0.168	0.928	0.300	0.986
Entry and exit contribution:						
Share of expansion due to entry	0.166	0.352	0.244	0.504	0.283	0.491
Share of contraction due to exit	0.229	0.504	0.304	0.579	0.351	0.589
Fraction of excess reallocation:						
Within industry	0.727	0.746	0.814	0.783	0.795	0.784

Source: Author's tabulations from the Danish VAT statistics data, 2002-2006.

The Danish labor market is characterized by high rates of excess reallocation, which is defined as a sum of gross contraction and expansion rates less the absolute value of a net change. Decomposing excess reallocation into between- and within-industry components, about 70-80% of excess reallocation can be attributed to within-sector reallocation. That is, shifts of output and resources happen mostly within four-digit industries.

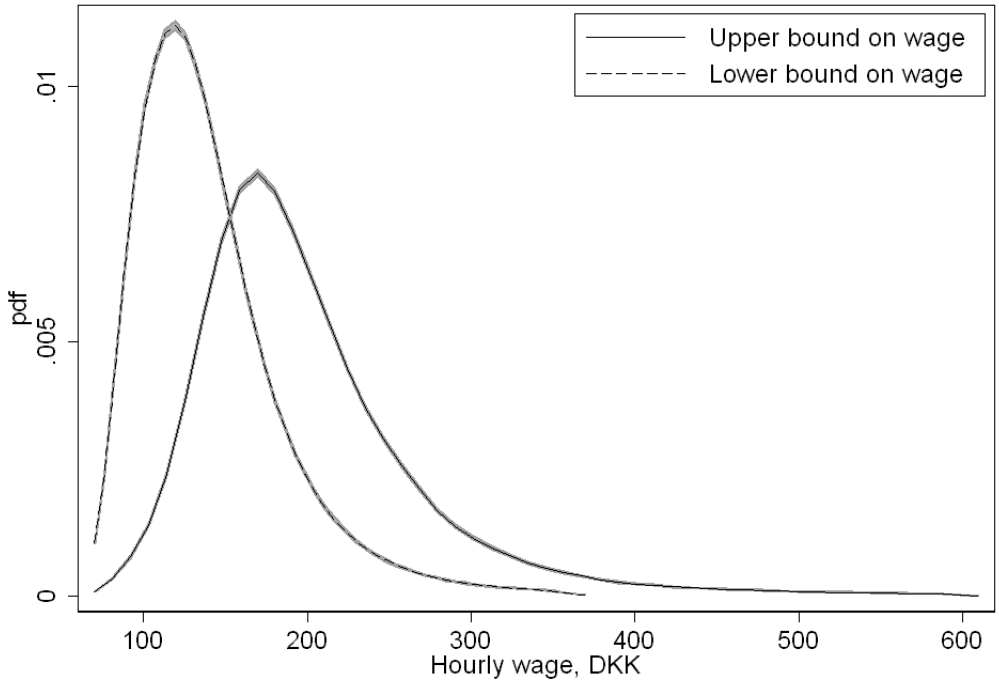
4.2 Labor productivity and wages

Figure 4.2 illustrates that there is a significant dispersion of average hourly wages found among firms. Two wage measures are presented here, based on the upper and lower bound measures of hours, as described in Section 3. The distribution function of wages, which are constructed using the upper bound of hours, exhibits a lower mean by construction; on top of that, it shows less dispersion and skewness. The 90th to 10th percentile ratio is 2.5 and the interquartile range of (log) wages is 0.4.

Figure 5 depicts non-parametric regression of wages on labor productivity.[11] More

[11]Non-parametric regressions in this paper are based on Nadaraya-Watson estimator (with Gaussian

Figure 4: Wage distribution



Notes: Density estimation is based on a Gaussian kernel with bandwidth of 5. Shaded areas are 90% pointwise bootstrap confidence intervals (clustered by firm ID). Source: Author's calculations based on the Danish firm data, 2006.

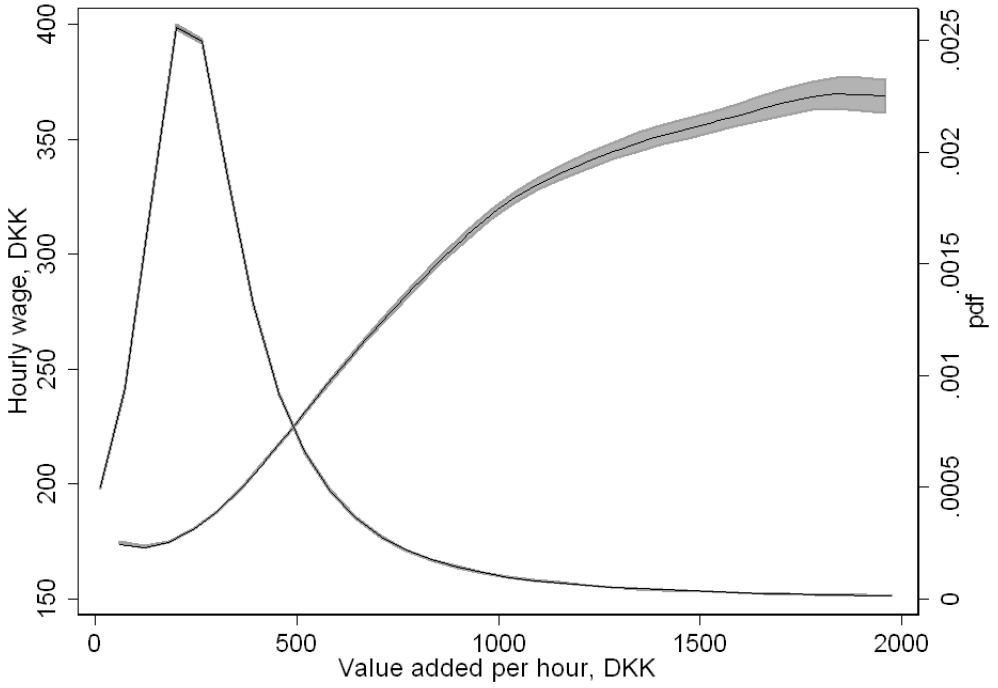
productive firms seem to pay higher wages on average, the finding that has been established for other countries and time periods (see for instance [20] for labor productivity and [8] for a TFP measure of productivity). The simple cross-section correlation between the two series is 0.15 (0.11 for hours-weighted series).[12] The relationship appears to be concave: an increase in wages is more pronounced for the lower part of the productivity distribution.

Moreover, a positive relation is also found between the growth rates of firm-level wages and productivity: firms that experience an increase in productivity raise wages that they pay to their workers (the correlation coefficient between first differences of log wages and log productivity is 0.42 (0.30 for hours-weighted series)). The fact that both wage and productivity dispersions are closely related suggests that there are incentives for workers to look for higher paying jobs and move to more productive firms. That,

or Uniform kernels) and confidence intervals are obtained by bootstrapping (see [32] for a theory and applications of kernel-based regressions and [27] for bootstrapping methods).

[12]The correlation between log wages and log productivity is 0.41 (0.14 for the hours-weighted series).

Figure 5: Relationship between wage and productivity.



Notes: Nadaraya-Watson estimate using a Gaussian kernel with bandwidth of 100. Shaded area is 90% pointwise bootstrap confidence intervals. Source: Author's calculations based on the Danish firm data, 2002-2006.

in turn, implies efficiency gains from labor reallocation and, potentially, a reduction in wage inequality.

4.3 Labor productivity and other factors

In the analysis below, I investigate the relationship between productivity differentials found across firms and other observable factors. First exercise is to quantify how much of the wage and productivity dispersion can be accounted for by differences between industries. I perform the variance decomposition of the total variance of hourly productivity into between and within (four-digit) industry components. Industry differences can explain up to 9% (17% for hours-weighted series) variation in labor productivity among firms, implying that more than 91% (83% for hours-weighted series) of variation in productivity exists within the same narrowly defined industry. This is consistent with the evidence presented in Table 3 that about 80% of the reallocation of labor resources also happens within the same industry. The variance decomposition for hourly wages

provides a similar result: the between-industry contribution to wage variation is 9% (32% for hours-weighted series).[13]

To analyze the effect of entry and exit on aggregate productivity while controlling for industry differences, I regress (log) labor productivity in 2002 on four-digit industry dummies and an exit indicator, which is equal to one if the firm did not survive until 2006. Similarly, I regress (log) labor productivity in 2006 on four-digit industry dummies and an entry indicator, which is equal to one if the firm has entered over the five-year period. Creative destruction models of, for instance, [3] and [24] suggest that productivity growth is driven primarily by entering firms that adopt new technologies and replace less productive older firms. These models would predict that entrants are more productive than continuing firms. Using hours-weighted series, the regression coefficients on exit and entry dummies are both negative and statistically significant at 1% level: -0.076 and -0.067, respectively.[14].The fact that continuing firms are more productive than both entrants and exiting firms suggests that selection is an important driver for productivity growth.

Table 4: Correlation between productivity and size.

	Value added per employee		Value added per hour	
	Non-weighted	Hours-weighted	Non-weighted	Hours-weighted
Value added	0.112	0.334	0.096	0.354
Employment	0.000	0.004	-0.002	0.009
Total hours	0.005	0.018	-0.002	0.019

Source: Author's tabulations from the Danish VAT statistics data, 2002-2006.

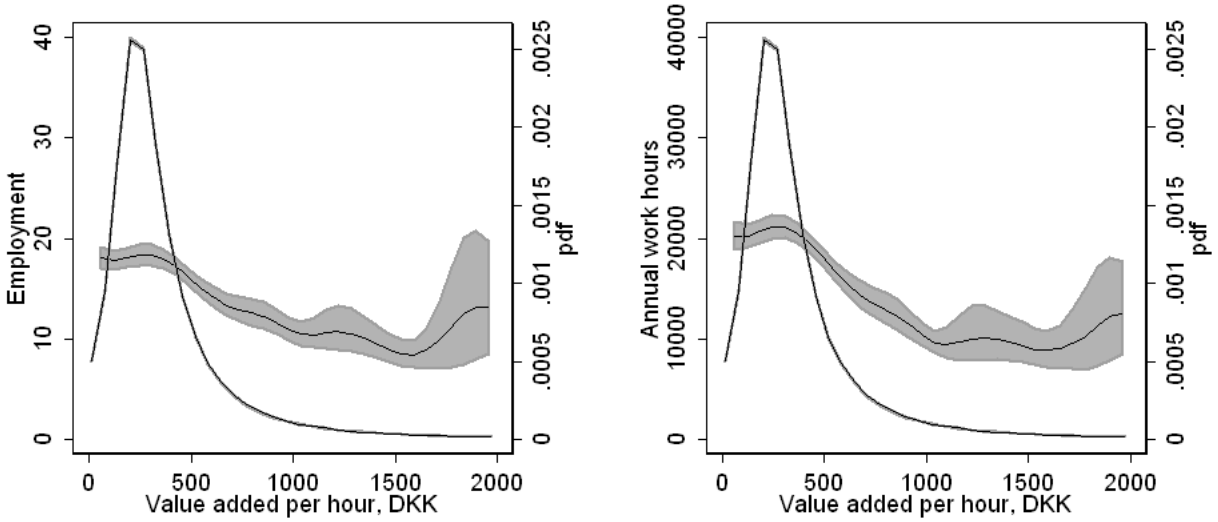
If technological progress is capital augmenting or neutral then we expect more productive firms to hire more people. However, the data seems to be at odds with this prediction as employment is virtually uncorrelated with productivity (Table 4). The non-parametric regression of employment on productivity is depicted in the left panel of Figure 6. Differences in labor utilization acros firms does not change this finding (see the right panel of Figure 6). These results are consistent with the findings reported in

[13]Using the log variables, a larger fraction of the variation can be explained by differences between industries. About 20% (60% for hours-weighted series) of variation in log productivity and 18% (40% for hours-weighted series) of the variation in log wages can be explained by the between-industry component.

[14]Non-weighted data shows that the regression coefficients on both entry and exit indicators are not statistically significant.

[29]. On the other hand, the relationship between the value added and productivity is found to be rather strong and positive and more so for size-weighted series (Figure 7). A positive correlation between output and labor productivity has been previously reported in the literature: [7], for instance, find that the correlation between the two series is 0.29 for an unbalanced panel of US manufacturing firms.

Figure 6: Relationship between labor input and productivity.

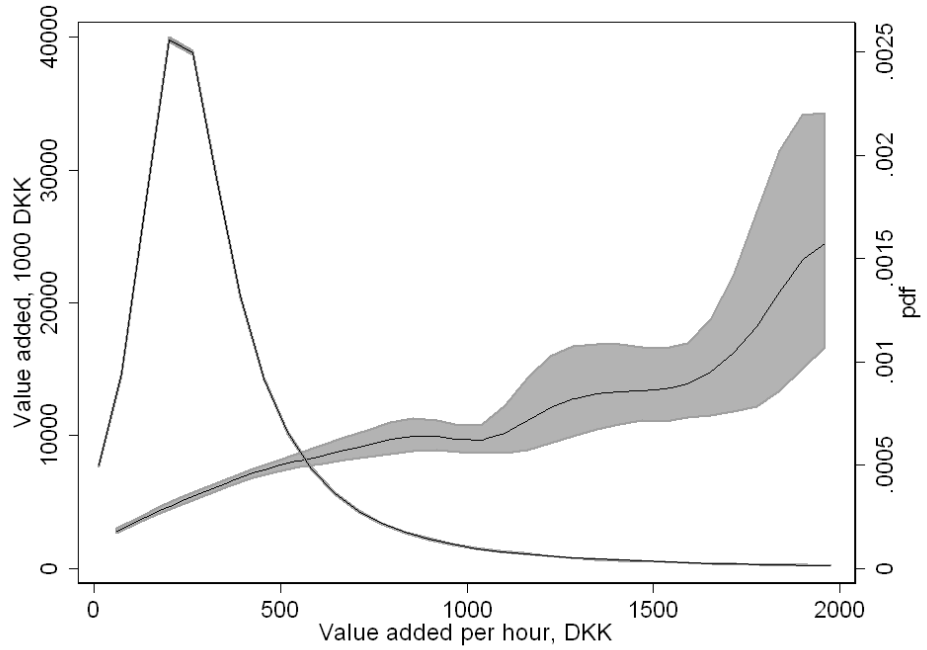


Notes: Nadaraya-Watson estimate using a Gaussian kernel with bandwidth of 100. Shaded area is 90% pointwise bootstrap confidence intervals (clustered by firm ID). Source: Author's calculations based on the Danish firm data, 2002-2006.

5 Job and worker flows

The timing and the extent of employment variation in response to productivity changes depends on labor adjustment costs, such as recruiting costs, layoff notice periods, mandated severance pay, etc. Many of these costs are related to various forms of labor market regulations. In fact, it is the current consensus in the literature that legal impediments to firing workers are responsible for the relatively sluggish employment growth that many European countries have experienced in recent decades (see for instance [23] and [28] for empirical studies, [10] for a theoretical model). To understand the extent to which labor adjustment costs may hinder the reallocation of labor resources from less to more productive firms, I examine labor dynamics patterns at the firm level.

Figure 7: Relationship between output and productivity.



Notes: Nadaraya-Watson estimate using a Gaussian kernel with bandwidth of 100. Shaded area is 90% pointwise bootstrap confidence intervals (clustered by firm ID). Source: Author's calculations based on the Danish firm data, 2002-2006.

This section presents key moments that pertain to firm-level employment dynamics with a particular focus on differences between net and gross employment changes. Net employment changes are regarded as being driven mostly by demand-side economic forces, such as an increase in the demand for the firm's product, technological changes, etc. Gross worker flows, on the other hand, may be affected by supply-side influences - such as movement into and out of the labor force, spouse's relocation, etc. - along with the demand-side events. Moreover, job and worker flows have different implications in terms of labor adjustment costs and employment protection regulations - to achieve the same net employment change firms may modify their attrition rates, as opposed to hiring or laying off employees. Finally, different labor market policies impact net and gross employment changes distinctly. For instance, a new-jobs tax credit acts through net changes in the firm's workforce; whereas the introduction of mandated severance pay affects employment changes mainly through gross worker flows. The goal of this section is to explore the channels of employment growth: do contracting firms shut down their hiring channels and rely on attrition or do they increase their separations, and vice versa, do growing firms raise their hiring rates or do they devote more

resources to retention rates?

Here, I follow the existing literature in constructing and analyzing job and worker flows at the firm-level (see for instance [19], [14] and the references therein). Monthly hires are computed as the number of individuals that are working in a given firm during month t but not during month $t-1$. Separation flows are equal to the number of workers that are employed in a given firm during month $t-1$ but not during month t. Job flows are defined as the number of jobs created in growing firms (job creation) and the number of jobs destroyed in contracting firms (job destruction) within month t. The corresponding rates are expressed in flows divided by the average employment in month t and $t-1$, according to the methodology of [18]. This procedure yields growth rates in the interval $[-2, 2]$ with endpoints corresponding to births and deaths.

The data at hand indicate that there is a fair amount of job and worker mobility in the Danish labor market (see Table 5). Hiring and separation rates average about 9% of employment. Average monthly job destruction and job creation rates are about 5-6% of employment (4% for continuing firms). That is, one of every 20 jobs on average is being destroyed from one month to the next.

Table 5: Average monthly job and worker flow rates.

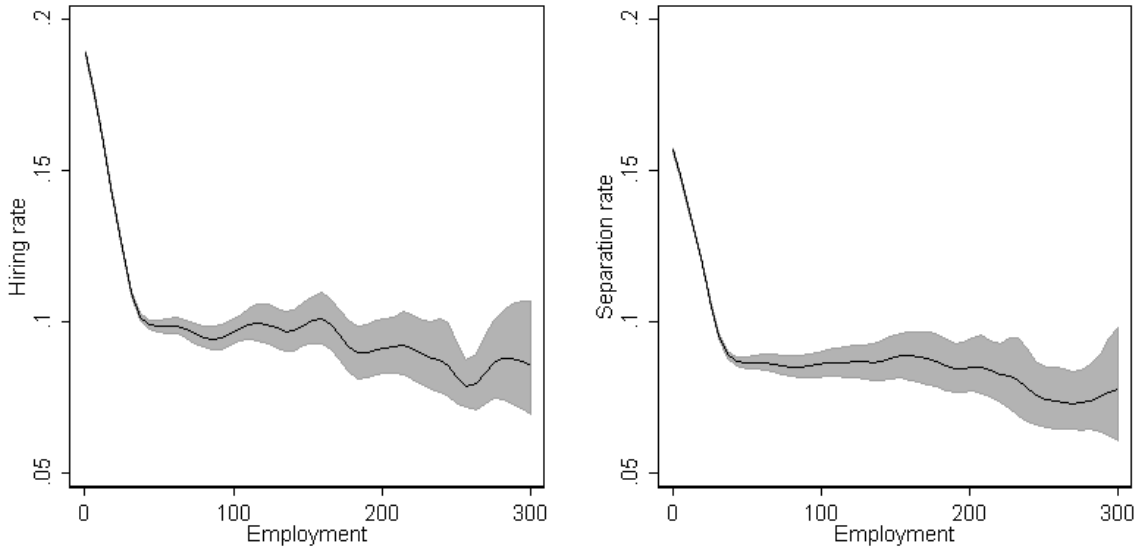
	Non-weighted	Emp. share-weighted	Emp. share-weighted, continuing firms
Hires	0.180	0.097	0.078
Separations	0.152	0.091	0.076
Job creation	0.158	0.061	0.041
Job destruction	0.129	0.054	0.039
Net employment change	0.029	0.006	0.002
Churning	0.046	0.074	0.075

Notes: Sample includes all private firms. Source: Author's tabulations from the Danish firm data, 1999-2006.

Hiring and separation rates in Denmark are twice higher than the rates in the US labor market (as reported by [19]), despite the fact that both countries have very flexible labor market. One reason for this difference in magnitudes of worker flows is various implicit mobility costs. For example, in the US a large fraction of employees is covered by employer-provided health insurance (as opposed to state-provide insurance in Denmark), which can be regarded as a part of the moving costs by the firm's employees. In fact, existing literature on job-lock in the US finds that workers with employer sponsored health benefits are less likely to change jobs due to the lack of alternative sources

of health insurance (see for instance [30]). An alternative explanation arises from differences in firm size distributions between the two countries: the average firm employs 10 workers in Denmark, while the average employment in the US is about 18 (see [6]). Smaller firms, in turn, have more volatile employment than larger firms do (see Figure 8). This is also evident from Table 5: the rates based on raw series are about twice as high as the size-weighted moments.

Figure 8: Relationship between monthly hiring and separation rates and employment.



Notes: The horizontal axis show average employment over two months. Nadaraya-Watson estimator based on a Gaussian kernel with bandwidth of 10. Shaded areas are 90% pointwise bootstrap confidence intervals (clustered by firm ID). Source: Author's calculations based on the Danish firm data, 2006.

Changes in employment are lumpy: more than a half of all firms do not change their labor force in a given month (these firms represent about one fifth of the total workforce). When firms adjust their employment, however, they do so by more than 14% (10% for continuing firms). The average time period between adjusting employment is 0.9 month. These results are consistent with many theoretical models of piecewise linear or non-convex labor adjustment costs (see [26] for a review).

To highlight differences between job flows and worker flows, I construct a worker churning rate, defined as the sum of hiring and separation rates less the absolute value of the net growth rate in employment (see [14] for more details on this measure). The churning rate refers to worker flows in excess of job flows. The fact that firms churn workers indicates that contracting businesses still hire workers and workers leave grow-

ing firms. The Danish economy is characterized by an average churning rate of 7.5% (see Table 5). Over the period of 1999-2006, job creation constitutes 32.2% of all (size-weighted) hires; while 30.6% of all separations are associated with job destruction.

Table 6 shows the relationship of monthly worker flows and firm employment adjustment, size-weighted by employment share. The firms are split into five groups according to their net employment growth rate. Firms that represent 50.3% of employment have monthly net employment growth between -2.5% and 2.5%. Contracting firms reduce their labor force mostly through separations; while growing firms increase their employment mostly through hiring. However, even contracting firms are hiring at 4.5% rate. These results appear to be qualitatively similar to those found in the US and Dutch labor markets (see [19] and [25], respectively), but are in contrast to the behavior of French firms reported by [2]. The latter paper finds that employment variation in France is made predominantly through the hiring margin; that is, even contracting establishments change their labor force primarily by reducing entry, as opposed to increasing their separation rates.

Table 6: Average monthly hiring and separation rates, by net employment growth rate.

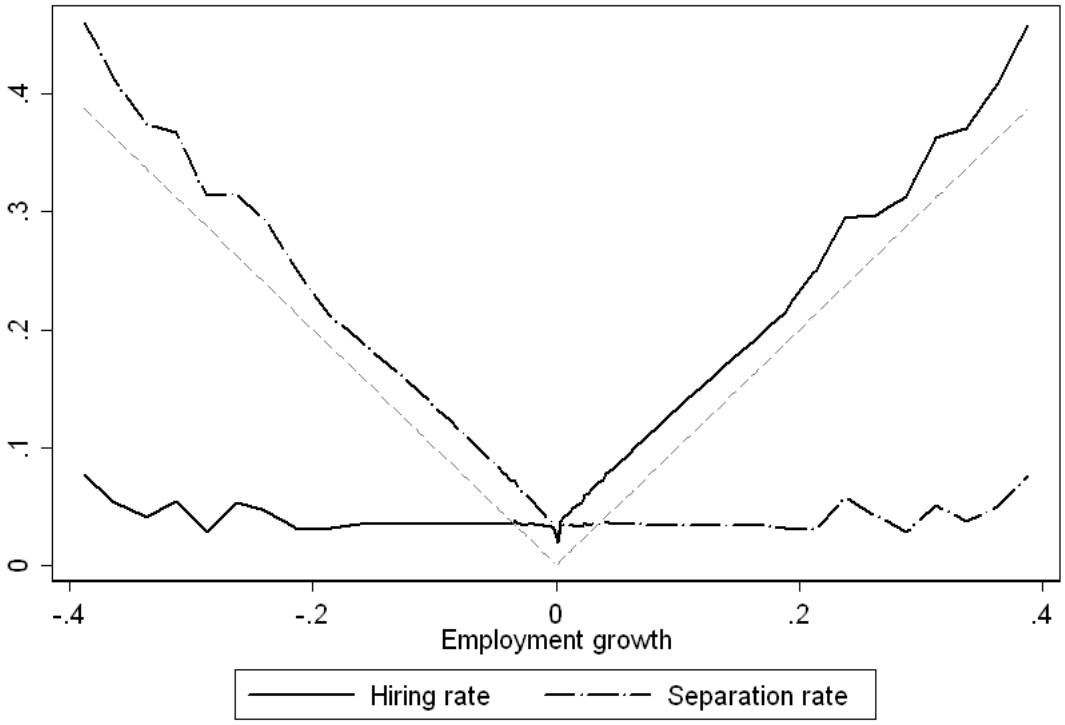
Net Emp. Growth	Hires	Sep.	Net	Emp. Share, %
Less than -0.10	0.045	0.496	-0.450	10.1
-0.1 to -0.025	0.040	0.093	-0.053	13.7
-0.025 to 0.025	0.035	0.035	0.000	50.3
0.025 to 0.10	0.093	0.040	0.053	14.8
More than 0.10	0.504	0.044	0.460	11.1
Total	0.097	0.091	0.006	100.0

Notes: Sample includes all private firms. Source: Author's tabulations from the Danish firm data, 1999-2006.

Figure 9 displays relationships of hiring and separation rates with net employment growth at the firm level. Similarly to the results reported for the US labor market by [19], the Danish firm data exhibit highly non-linear association between the two rates and net employment growth with a sharp kink at zero. That is, expanding firms rely primarily on hires, as opposed to adjusting retention rates. Conversely, contracting firms appear to sustain hiring rates while increasing their separations. [19] also observe that separations seem to rise more sharply to the right of zero than hires rise to the left of zero. The reason for that, as they remark, is that expanding establishments have a greater need for new hires, which in turn have a greater separation propensity. However, no evidence for such asymmetry between the two series is found in the Danish data. Also, the variability

of hiring and separation rates is about the same in Denmark: the standard deviation of monthly series is 24.3% for hires and 22.9% for separations.

Figure 9: Relationship between monthly hiring and separation rates and net employment growth.



Notes: Following the methodology of [19], the two series are constructed as the mean hiring and separation rates for narrow growth rate bins that range from 0.0025 to 0.05, with narrower bins closer to zero. Dashed lines are 45-degree lines from the origin. Source: Author's calculations based on the Danish firm data, 2005.

A flexible labor market in combination with a generous unemployment insurance system in Denmark gives rise to a fairly frequent use of temporary layoffs. In order to examine worker flows within a quarter, I construct two measures of hires and separations. The first measure is derived by contrasting employment in the third month of two consecutive quarters; while the second (cumulative) measure sums monthly flows over each quarter. Comparing the two measures, it appears that about two fifths of all hires and separations arise in connection with employment relationships lasting less than a quarter. Moreover, about 30% of all individuals hired during a quarter were employed at the same firm during the previous quarter.

Table 7 highlights the differences in worker flows by broad industry groups (in accor-

dance with the standard Statistical Classification of Economic Activities in the European Union - NACE). Worker turnover is relatively low in Financial Intermediation, Manufacturing, and Electricity, Gas and Water Supply sectors and relatively high in Agriculture, Fishing, Hotel and Restaurants and Other Social and Personal Services.

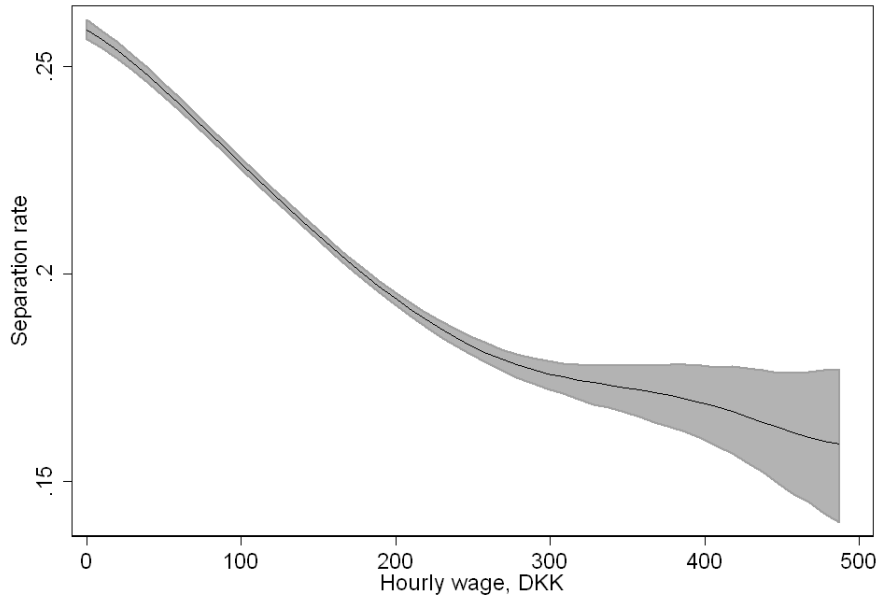
Table 7: Average quarterly hiring and separation rates, by industry.

	Hiring rate		Separation rate	
	3^{rd} month	Cumulative	3^{rd} month	Cumulative
Agriculture	0.197	0.330	0.198	0.331
Fishing	0.239	0.445	0.246	0.452
Mining and quarrying	0.120	0.214	0.104	0.198
Manufacturing	0.107	0.167	0.109	0.169
Electricity, gas and water supply	0.086	0.169	0.090	0.173
Construction	0.142	0.211	0.132	0.201
Wholesale and retail trade	0.128	0.184	0.127	0.183
Hotels and restaurants	0.253	0.423	0.260	0.430
Transport and communication	0.141	0.231	0.138	0.228
Financial intermediation	0.077	0.147	0.076	0.146
Real estate and business activities	0.180	0.294	0.177	0.291
Education, health and soc. work	0.125	0.220	0.126	0.221
Other social and pers. services	0.216	0.442	0.214	0.440
Total	0.140	0.226	0.139	0.225

Notes: Moments are size-weighted by employment share. Source: Author's tabulations from the Danish firm data, 1999-2006.

If firms devote resources to adjust their retention rates, we would expect to see a negative association between separations and hourly wages. A number of theoretical models predict higher separation rates in low-pay jobs. For instance, according to the search model of [13], the firms are indifferent between a lower pay and a higher turnover or a higher pay and a lower turnover, thus creating a negative association between wages and separations. Figure 10 presents a non-parametric regression of the separation rate on the lower bound of hourly wages. As anticipated, the Danish labor market exhibits a negative relationship between the separation rate and the average firm hourly wages. Moreover, the decline in separations is more pronounced for the lowest part of the wage distribution.

Figure 10: Relationship between the quarterly (cumulative) separation rate and wages.



Notes: Nadaraya-Watson estimator based on a Gaussian kernel with bandwidth of 20. Shaded areas are 90% pointwise bootstrap confidence intervals (clustered by firm ID). Source: Author's calculations based on the Danish firm data, 2006.

6 Hours and employment trade-off

Labor adjustment costs may hinder firms from adjusting their workforce in response to productivity changes. In that way, adjustment costs slow down reallocation of labor resources from less to more productive firms. In the short run, however, firms can respond to productivity fluctuations by varying their labor utilization. Consequently, hours of work become an important channel through which firms can modify their use of labor resources and economize on hiring and firing costs. This section aims at delivering empirical evidence of the short-term trade-off between changes in the number of workers and their average work hours at the firm level.

The key questions to address are to what extent firms vary average work hours of their employees and whether the dynamic interaction between the firm's workforce and its utilization is consistent with adjustment costs models (see for instance [15] and [17]). If hiring is impeded by search frictions then average work hours overshoot in response to a positive shock and start falling as the firm's labor force builds up to its new desired level. In that case, we expect to see hours and employment moving in reverse directions in the data. Likewise, a negative shock in combination with mandated layoff notice

produces an immediate hours response and a more sluggish employment drop, thus generating a similar negative co-movement of these two variables.

The labor adjustment models predict that firms would eventually adjust their employment to its optimal level after a sufficient period of time; therefore, the dynamic trade-off between the number of workers and their work hours exists only in the short run. In order to test this hypothesis, we need to observe changes in the firm-level hours and employment on a fairly frequent basis. A scarcity of high-frequency micro data on work hours is the main reason for the lack of a detailed analysis of the hours-employment trade-off. The existing empirical literature on labor adjustment that exploits information on work hours is limited to industry-level data or uses establishment-level data that pertain to the US manufacturing sector and that are more than three decades old.[15] The empirical analysis in this paper is based on a unique dataset that includes information on work hours and employment on a quarterly basis.

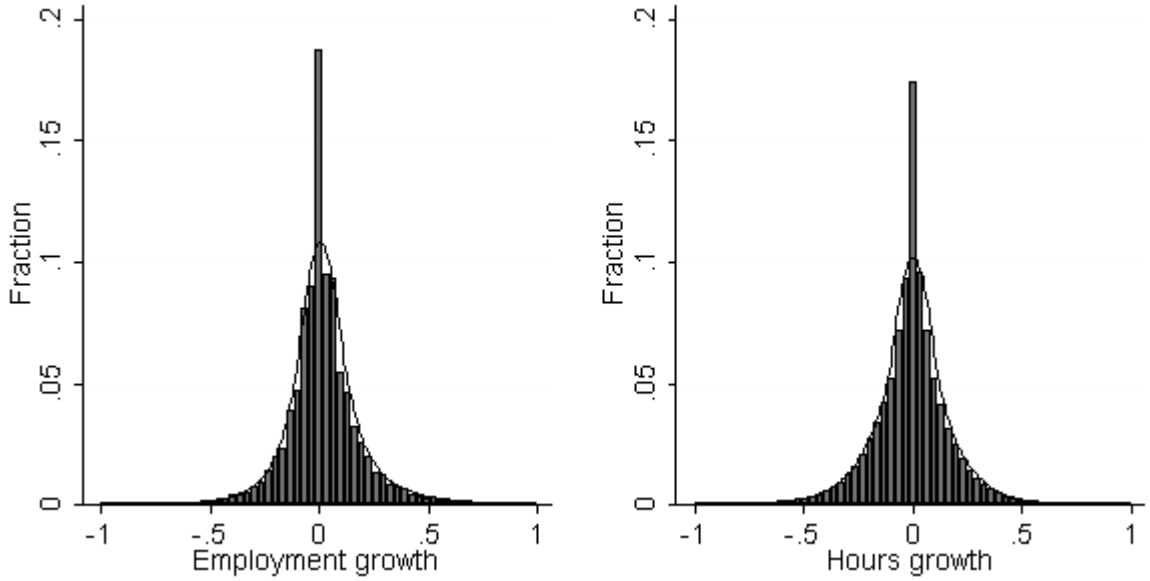
I construct an average work hours series (h_t) as the total work hours derived from equation (LB) divided by quarterly employment. I focus on the growth rates of hours and employment expressed as first differences of log variables. The results reported here are based on raw series, as well as employment share-weighted moments. In addition, I remove aggregate time effects from the original series and explore the cross-sectional variation in the growth rates of hours and employment.

Figure 11 depicts histograms of the growth rates of both variables. First, we observe a significant inaction region in both hours and employment. A spike at zero change in the average work hours is not surprising given the interval nature of the hours variable (recall that the hours variable may mask some of the variation in actual hours if workers do not switch between intervals). The growth of employment is measured more precisely and thus is more informative about the region of zero employment adjustment: about 18% of firms employ the same number of workers in any two consecutive quarters. Much lower magnitudes of employment changes have been reported in empirical studies that look at other European countries. [33], for instance, find that employment remains unaltered over the course of a quarter for 74.7% of the establishments in a representative sample of Portuguese firms. This finding suggests that the Danish labor market, in comparison to other European countries (especially in continental Europe), is characterized by relatively low adjustment costs.

Second, despite the fact that hours are measured in intervals, there is a significant

[15] See for instance [31], [26] for applications based on the industry-level data. [16] build their analysis on the Longitudinal Research Database, which includes quarterly work hours information at the establishment level for a sample of manufacturing firms for the period of 1972-1980.

Figure 11: The growth rates of employment (left panel) and average work hours (right panel).



Notes: Vertical axis show a fraction of firm-quarter observations. Density estimation is based on a Uniform kernel with bandwidth of 0.1. Source: Author's calculations from the Danish firm data, 1999-2006.

variation in hours growth. In fact, the standard deviation of hours and employment growth is about the same (see Table 8). This finding provides some evidence that firms use both intensive and extensive margins to make adjustments to their labor input.

Table 8: Relationship between the growth rates of hours and employment.

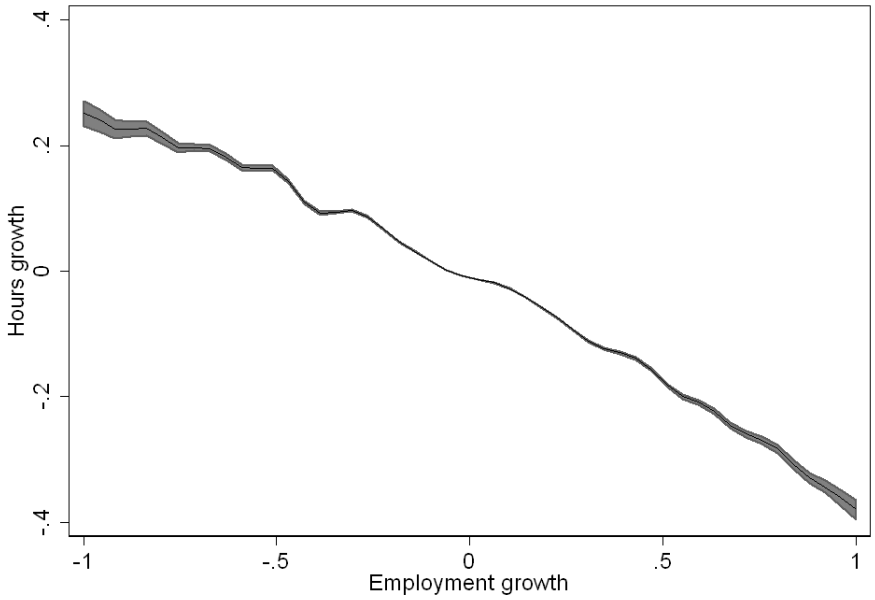
	Non-weighted	Emp.share-weighted, no time effects
Std. dev. $(\Delta \log N_t)$	0.277	0.221
Std. dev. $(\Delta \log h_t)$	0.285	0.229
Corr$(\Delta \log N_t, \Delta \log h_t)$	-0.300	-0.443
Corr$(\Delta \log N_t, \Delta \log h_{t-1})$	0.078	0.113

Source: Author's tabulations from the Danish firm data, 1999-2006.

Secondly, similarly to the results reported by [16] for the US labor market, I find a negative correlation between hours and employment growth at the firm level. Figure 12 shows a non-parametric regression of hours growth on workforce growth. The hours-employment growth relationship is monotone and the negative correlation between the

two series is observed for virtually all values of employment growth. Moreover, changes in hours lead changes in employment: there is a positive association between employment growth this period and hours growth last period. Both of these findings are consistent with labor adjustment costs models.

Figure 12: Relationship between hours growth and employment growth.



Notes: Nadaraya-Watson estimator based on a Gaussian kernel with bandwidth of 0.025. Shaded areas are 90% pointwise bootstrap confidence intervals (clustered by firm ID). Source: Author's calculations based on the Danish firm data, 1999-2006.

Table 9 reports the correlation between hours and employment growth by broad industry groups (in accordance with NACE classification). The results show that the hours-employment relationship is weaker in Hotels and Restaurants, Fishing and Construction sectors. These industries are associated with relatively low-skilled labor and presumably with lower adjustment costs. Recall that Hotels and Restaurants and Fishing sectors also exhibit relatively high hiring and separation rates. On the other hand, Real Estate and Business Activities and Transport and Telecommunication demonstrate a stronger association between growth rates of hours and employment.

Previous studies on labor adjustment costs that use micro level data refer to the manufacturing sector only (see [16]). One of the advantages of using Danish firm data is the possibility of comparing the manufacturing industry to the overall population of firms. According to Table 9, the manufacturing sector (that comprises 26% of overall

Table 9: Correlation between growth rates of average hours of work and employment, by industry.

	Non-weighted	Weighted, no time effects	Emp. share,%
Agriculture	-0.314	-0.373	2.04
Fishing	-0.219	-0.241	0.12
Mining and quarrying	-0.299	-0.311	0.15
Manufacturing	-0.287	-0.493	25.96
Electricity, gas and water supply	-0.739	-0.384	0.56
Construction	-0.141	-0.253	9.19
Wholesale and retail trade	-0.295	-0.370	23.75
Hotels and restaurants	-0.220	-0.186	3.83
Transport and communication	-0.298	-0.525	6.85
Financial intermediation	-0.492	-0.356	5.09
Real estate and business activities	-0.367	-0.572	14.95
Education, health and social work	-0.392	-0.387	2.42
Other social and personal services	-0.452	-0.551	5.00

Notes: Employment share does not sum up to 100% because 0.09% of workers are employed at firms with missing industry information. Source: Author's tabulations from the Danish firm data, 1999-2006.

employment in Denmark) is characterized by a more negative correlation coefficient than overall economy (-0.49 and -0.44, respectively). Although the gap between the two coefficients is statistically significant at 1% level; the magnitude of this difference is fairly small (especially if compared to the difference between some of the other industries, for instance Hotels and Restaurants, and the overall economy).

The variation in hours can act as a buffer against various demand and productivity shocks. However, it may still be costly for a firm to change hours of work due to the overtime premium and other regulations. In fact, the negative relationship between the employment and hours per worker growth rates arises from two sources: first, labor adjustment costs that halt the adjustment in the number of workers and, second, the costs of changing work hours. If variations in hours are inexpensive then firms would make all adjustment on the intensive margin, as opposed to hires and layoffs. Thus, the next question that this paper addresses is whether hourly wages are increasing in work hours in the Danish labor market.

Existing studies support the claim that variations in hours are expensive: ample empirical evidence for the negative part-time/full-time wage premium has been documented in the literature (see [11] for a review). Most of the studies try to measure the

effect of work hours on wages based on individual data. A major challenge is to find a way how to identify whether changes in hours affect wages or changes in wages affect hours. A recent paper of [1] documents a 25% wage penalty for men who cut their work week from 40 to 20 hours; however, it reports no such effect on women. This paper does not intend to make any statement about the causality; instead, it documents the mere correlation between wages and hours of work at the firm level; that is, whether firms that employ workers for longer hours also pay higher wages on average.

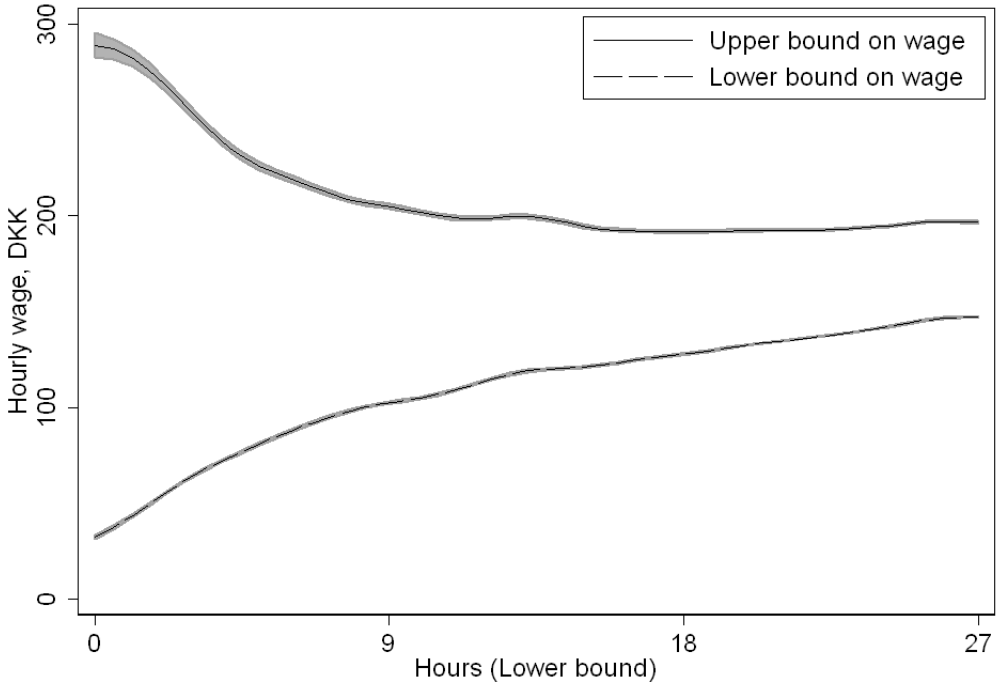
The hourly wage measure is constructed as the ratio of total payroll cost paid in a given quarter to the total work hours, where hours are measured, as before, at their lower bound. Wages defined in this manner represent the upper bound on actual hourly wages. The correlation between wages and work hours, turns out to be slightly negative in the data. One explanation for this counterintuitive finding is the mis-measurement of wages: if wages are overestimated relatively more for low values of hours then we expect to see a decline in hourly wages as hours rise. For that reason, I use an alternative (lower bound) measure of wages, based on H_{UB} hours variable as described in Section 3 (recall that H_{UB} measure assigns the right boundary of each 9-hour interval to all employees with positive pension contributions and 9 hours of work to employees with zero contributions).

Figure 13 displays the relationship between the two measures of wages and work hours. The difference between the two curves is most prominent for low values of hours, mainly due to the fact that the latter measure accounts for employees that work less than 9 hours. The upper bound on wages displays a marked drop in wages for low values of hours. On the contrary, the lower bound on wages is undoubtedly increasing in hours. Hence, I conclude that the negative association between wages and hours is attributable predominantly to the measurement noise.

7 Conclusions

Evidence presented in this paper suggests that the reallocation of labor resources from less to more productive firms is an important factor enhancing aggregate productivity growth. In particular, this paper documents sizable and persistent productivity and wage differentials found among firms in the Danish labor market. There is significant turnover of businesses in terms of productivity ranking associated with reallocation of labor resources. Over a year, more productive firms increase their use of labor resources (raising both employment and average work hours) by up to 8%, whereas less

Figure 13: Relationship between wages and work hours.



Notes: Nadaraya-Watson estimator based on a Gaussian kernel with bandwidth of 0.5. Shaded area is 90% pointwise bootstrap confidence interval around upper and lower bound on hourly wage. Source: Author's calculations from the Danish firm data, 2006.

productive firms lose their workforce at a 2.5% rate and their total labor input at a 14% rate. Most of the reallocation of labor inputs happens within the same narrowly defined industries. Over the period of 2002-2006, about half the expansion and contraction in labor input is accounted for by entering and exiting firms, respectively.

The reallocation of labor resources from less to more productive firms to a large extent depends on flexibility of the labor market and the ease of hiring and firing. The new administrative data sources presented in this paper allow for a detailed analysis of firm-level employment and hours dynamics. Firstly, I show that the Danish labor market is characterized by considerable magnitudes of job and worker flows: monthly hiring and separation rates average about 9 percent; whereas job creation and destruction rates exceed 5 percent. These rates are twice as high as the rates found in the US labor market. Relatively high labor market flexibility in combination with a generous unemployment insurance scheme in Denmark results in a high incidence of temporary layoffs: about two fifths of all quarterly hires and separations arise in connection with employment

relationships lasting less than a quarter.

Secondly, this paper presents empirical evidence that worker flows and job flows are quite distinct. In fact, only about 30% of monthly hires and separations arise in connection with job creation and destruction. Different implications of job and worker flows in terms of adjustment costs and labor market policies call for a theory that explicitly models hiring and separation decisions of firms. This study also finds that expanding firms rely primarily on hires; while contracting firms sustain their hiring rates and increase their separations.

The empirical evidence suggests that firms use variation in hours to mitigate changes in the number of workers: the standard deviation of hours and employment growth rates is about the same. Work hours per employee and employment are moving in opposite directions at the firm level; furthermore, lagged changes in hours are positively correlated with changes in employment. These observations are consistent with adjustment costs models that predict that in the event of a shock to the firm's productivity or the demand for the firm's product, hours of work adjust immediately, while the response of employment is more sluggish. In sum, hours of work is an important channel, through which firms modify their use of labor resources, and hence it has to be accounted for when analyzing the effect of labor market frictions on labor dynamics.

References

[1] Aaronson D, French E (2007) Product Market Evidence on the Employment Effects of the Minimum Wage, J of Labor Economics 25(1)

[2] Abowd JM, Corbel P, Kramarz F (1999) The Entry and Exit of Workers and the Growth of Employment: An Analysis of French Establishments, Review of Economics and Statistics 81(2): 170-187

[3] Aghion P, Howitt P (1992) A Model of Growth Through Creative Destruction, Econometrica 60(2): 323-351

[4] Andersen SK, Mailand M (2005) The Danish Flexicurity Model: The Role of the Collective Bargaining System, Employment Relations Research Center Discussion Paper, September 2005

[5] Andersen TM, Svarer M (2007) Flexicurity - Labour Market Performance in Denmark, CESIFO Working Paper 2108

[6] Axtell RL (2001) Zipf Distribution of US Firm Sizes, Science CCXCIII: 1818-1820

[7] Baily MN, Bartelsman EJ, Haltiwanger JC (2001) Labor Productivity: Structural Change and Cyclical Dynamics, Review of Economics and Statistics 83 (3): 420-433

[8] Baily MN, Hulten C, Campbell D (1992) Productivity Dynamics in Manufacturing Plants, Brookings Papers on Economic Activity. Microeconomics 1992: 187-267

[9] Bartelsman EJ, Doms M (2000) Understanding Productivity: Lessons from Longitudinal Microdata, J of Economic Literature 38(3)

[10] Bentolila S, Bertola G (1990) Firing Costs and Labour Demand: How Bad is Eurosclerosis, Review of Economic Studies 57 (3): 381-402

[11] Blank R (1990) Are Part-Time Jobs Bad Jobs? In: Burtless G (ed) A Future of Lousy Jobs? The Changing Structure of U.S. Wages. The Brookings Institution, Washington, DC

[12] Botero JC, Djankov S, La Porta R, Lopez de Silanes F, Shleifer A (2004) The Regulation of Labor, Quarterly J of Economics 119: 1339-1382

[13] Burdett K, Mortensen DT (1998) Wage Differentials, Employer Size, and Unemployment, International Economic Review 39(2)

[14] Burgess S, Lane J, Stevens D (2001) Churning Dynamics: An Analysis of Hires and Separations at the Employer Level, Labor Economics 8 (1): 1-14

[15] Caballero RJ, Engel EM (1992) Beyond the Partial Adjustment Model, American Economic Review 82 (2): 360-364

[16] Cooper RW, Haltiwanger JC, Willis JL (2007) Implications of Search Frictions: Matching Aggregate and Establishment-Level Observations, NBER Working Paper 13115

[17] Cooper RW, Haltiwanger JC, Willis JL (2004) Dynamics of Labor Demand: Evidence from Plant-level Observations and Aggregate Implications, NBER Working Papers 10297

[18] Davis SJ, Haltiwanger JC, Schuh S (1996) Job Creation and Destruction. MIT Press, Cambridge, MA

[19] Davis SJ, Faberman RJ, Haltiwanger JC (2006) The Flow Approach to Labor Markets: New Data Sources and Micro-Macro Links, J of Economic Perspectives 20(3)

[20] Dunne T, Foster L, Haltiwanger JC, Troske K (2002) Wage and Productivity Dispersion in the US Manufacturing: The Role of Computer Investment, IZA Discussion Paper 563

[21] Foster L, Haltiwanger JC, Krizan CJ (2006) Market Selection, Reallocation, and Restructuring in the US Retail Trade Sector in the 1990s, Review of Economic Studies 88: 748-758

[22] Foster L, Haltiwanger JC, Krizan CJ (2001) Aggregate Productivity Growth: Lessons from Microeconomic Evidence. University of Chicago Press, Chicago

[23] Goux D, Maurin D, Pauchet M (2001) Fixed-term Contracts and the Dynamics of Labour Demand, European Economic Review 45(3): 533-552

[24] Grossman GM, Helpman E (1991) Innovation and Growth in the Global Economy. MIT Press, Cambridge, MA

[25] Hamermesh DS, Hassink WHJ, van Ours JC (1996) New Facts about Factor-Demand Dynamics: Employment, Jobs, and Workers, Annales dEconomie et de Statistique 41/42: 21-39

[26] Hamermesh DS, Pfann GA (1996) Adjustment Costs in Factor Demand, J of Economic Literature 34(3): 1264-1292

[27] Horowitz JL (1997) Bootstrap Methods in Econometrics: Theory and Numerical Performance. In: Kreps D M, Wallis K F (eds) Advances in Economics and Econometrics: Theory and Applications, Vol. 3 of Econometric Society Monograph. Cambridge University Press, Cambridge

[28] Kramarz F, Michaud M-L (2004) The Shape of Hiring and Separation Costs, IZA Discussion Papers 1170

[29] Lentz R, Mortensen DT (2008) An Empirical Model of Growth Through Product Innovation, Econometrica 76(6)

[30] Madrian BC (1994) Employment-Based Health Insurance and Job Mobility: Is There Evidence of Job-Lock, Quarterly J of Economics 109(1): 27-54

[31] Nadiri IM, Rosen S (1973) A Disequilibrium Model of Demand for Factors of Production. National Bureau of Economic Research, New York

[32] Simonoff JS (1996) Smoothing Methods in Statistics. Springer, New York

[33] Varejao J, Portugal P (2007) Employment Dynamics and the Structure of Labor Adjustment Costs, J of Labor Economics 25(1): 137-165